LIGHTING THE HIGHWAYS

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THE ever increasing number of highway accidents directly attributable to inadequate illumination has led the public press, notably those popular publications devoted to science and mechanics, to give considerable space to the discussion of the sodium vapor lamp as applied to highway illumination. This article is intended to give the engineering student a brief discussion of what the sodium vapor lamp is, what it does, and why it is superior in many ways to other illuminants for this purpose.

The sodium vapor lamp in itself is not a new idea, but it is only recently that it has been possible to construct bulbs which could resist the corrosive action of the hot sodium vapor. With this obstacle recently removed, the sodium vapor lamps are now commercially available and lend themselves admirably to use in highway illumination for reasons which will be shown later.

The light produced by the sodium vapor lamp is a by-product of the processes by which the gaseous sodium is rendered a conductor of electricity[1] (as contrasted with the incandescent lamp in which the light is a by-product of the heat developed in the lamp by the passage of an electric current through the filament.) It is due to the inherent characteristics of these two different methods of production of light that the sodium vapor lamps show so much higher luminous efficiency than incandescent lamps. A sodium vapor lamp can be made to yield more than two and one-half times as much light as a gas filled incandescent lamp consuming the same power. One of the advantages of the sodium vapor lamp is thus immediately self-evident.

[1] Dushman, Production of Light from Discharges in Gases, *General Electric Review,* Vol. 37, No. 6, June, 1934, pp. 260-268.

It has been shown by actual test that the resolving power of the eye (visual acuity) is much greater[2, 3] under a light source giving a single color (monochromatic) than one composed of a multitude of colors (white light is such a complex or heterochromatic light). It has been further shown that this resolving power is much greater for those colors lying in the center of the visible spectrum. The sodium light fits this condition very well as the light given by the sodium vapor lamp lies almost at the maximum of the visibility curve.[4] It should be noted in this connection, however, that a monochromatic light is of advantage in quantitative rather than qualitative vision, as the colors are badly distorted under such a source of illumination. This lack of color discrimination, however, has no particular disadvantage in highway lighting. When using a monochromatic light, an object upon the highway is seen as a distinct dark silhouette against the light background of the pavement.

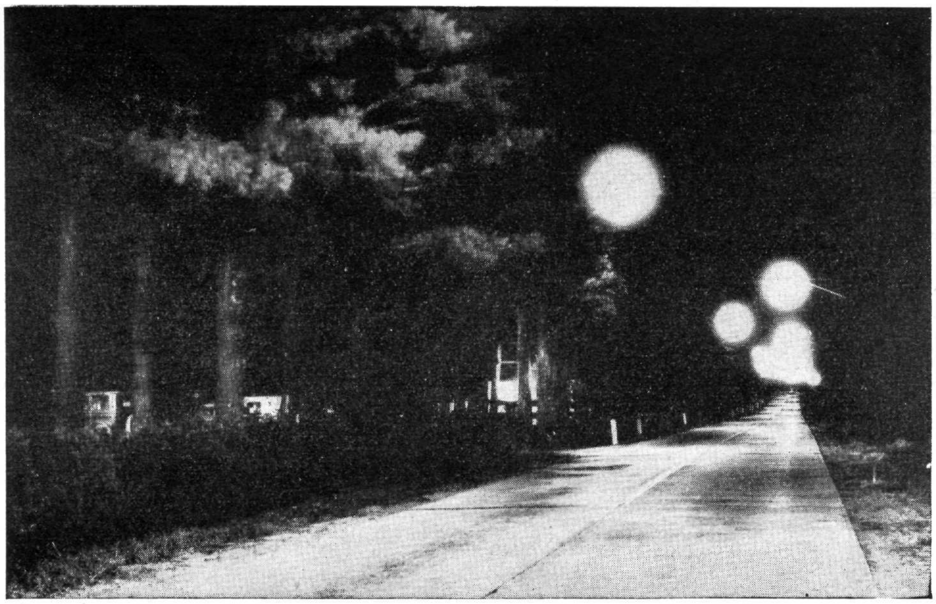
Although the above-mentioned items are the most important advantages of the sodium vapor lamp they are not wholly responsible for its adaptability to highways. Other advantages include low surface brightness, the ability to produce large amounts of light with little glare, and the large size of the source, making possible proper distribution of light over the desired area with simple redirecting devices.

The lamp proper consists of a glass tube or globe

[2] Luckiesh and Moss, Visual Acuity and Sodium Vapor Light, *Journal of the Franklin Institute,* Vol. 215, No. 4, April, 1933, pp. 401-410.

[3] Luckiesh and Moss, Seeing in Sodium Vapor Light, *Journal of the Optical Society of America,* Vol. 24, January, 1934, pp. 5-13.

[4] Dushman, *G. E. Rev.* June, 1934, p. 260.



SODIUM VAPOR LIGHTING
BALLTOWN ROAD
NEAR
SCHENECTADY, N. Y.

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containing the inert gas neon at a very low pressure, and a small amount of sodium. The inside of the globe is coated with a sodium resistant glaze. Until this glaze was developed, the life of a sodium vapor lamp was very short, being only a few hours. Now, however, manufacturers guarantee a life of 2000 hours. The electrical elements consist of a filament similar to that used in an incandescent electric lamp and two molybdenum rings located at opposite ends of the tube. In operation the filament is heated to incandescence and a direct current power supply is applied to the metallic rings. When the arc first appears the red glow so familiar in the popular neon signs is produced. As the sodium vapor pressure increases due to the rise of temperature of the lamp, the glow changes into an intense yellow light, the color of which is familiar to the student of elementary chemistry in connection with the flame test for sodium.

The sodium vapor lamp may also be used on alternating current by the addition of special rectifying equipment.[6] This auxiliary equipment requirement has been one of the chief drawbacks for the lamp but this is being rapidly overcome by the developing engineers.

A typical set of operating conditions for a d-c. sodium vapor lamp[5] are as follows:

Operating temperature	200 deg. C.
Arc current	5.0 amperes
Voltage drop in the arc	13 volts
Filament current	8.6 amperes
Filament voltage	1.8 volts

Thus, it may be seen that the above lamp consumes a total power of 82 watts and under these conditions a luminous efficiency of 40 to 50 lumens per watt. (Compare this with a 100-watt gas-filled incandescent lamp which gives a luminous efficiency of 14.4 lumens per watt.) More recent alternating current lamps of the sodium vapor type are claimed to give a luminous efficiency of 50 to 55 lumens per watt.

In actual installation the lamp proper is enclosed in a vacuum flask (a double walled glass globe from which the air has been evacuated) to retard the flow of heat from the lamp. This combination is then enclosed in the luminaire. The luminaire consists of two distinct reflecting surfaces, one a plane surface and the other a parabolic reflector.

The sodium vapor illumination for highways may be used on either series (constant current, such as is used in street lighting) or multiple (constant voltage) circuits.

The alternating current lamps require a set of auxiliary apparatus which is supported on the pole at the curb. This equipment includes cathode heating autotransformers, an electrically operated timer for providing a short cathode-heating interval before the arc is struck, and radio interferenc suppressors. In the series circuit equipment there is also included the usual film cut-out to prevent all the lamps in the circuit from being extinguished in case of the failure of one lamp.

Experimentation upon this method is being carried out both with model highways and on actual highways under operating conditions. The General Electric Company at its research laboratories at Nela Park, Cleveland, is using a model (1/8 scale) of a 30-foot highway representing a 2000-foot road stretch.

Notable among the full scale installations is that of the Balltown Road lying between the Schenectady-Albany and Schenectady-Troy highways in New York State.[8] This road is a 20-foot, natural-finish reinforced concrete highway 2270 feet long. The installation was sponsored jointly by the General Electric Company and the New York Power and Light Corporation and was first placed in regular operation on June 12, 1933.

This installation consisted of nine 4000 lumen d-c. units spaced 250 feet apart. The lamps are located near the edge of the pavement and are staggered, i. e., successive lamps being alternately placed on opposite sides of the road. An additional system of thirteen units was installed so that in conjunction with five of the original system the highway could be lighted by eighteen lamps with a spacing of 125 feet.

Later (Feb. 1, 1934) this installation was replaced by one consisting of eight 10,000 lumen a-c. sodium vapor lamps with staggered 250 foot spacing. Along with these were installed eight 10,000 lumen incandescent lamps to obtain an accurate comparison of the two methods of illumination. It was found that the sodium vapor provided a slightly higher illumination, and consumed less power than the incandescent lamp installation. It was shown that excellent visibility, soft attractive color, and freedom from glare made the illumination by the sodium lamp more satisfactory than with the incandescent lamps.

[5] Gordon, Operating Characteristics of Sodium Vapor Lamps, *General Electric Review,* Vol. 37, No. 7. July, 1934, pp. 338-341.

[6] Fonda and Young, The A-C. Sodium Vapor Lamp, *General Electric Review,* Vol. 37, No. 7. July, 1934, pp. 331-337.

[7] Westendorp, Circuits for Sodium Vapor Lamps, *General Electric Review,* Vol. 37, No. 8, August, 1934, pp. 368-371.

[8] Eddy, Sodium Vapor Highway Lighting on Balltown Road at Schnectady, N. Y., *General Electric Review,* Vol. 37, No. 8, pp. 372-377.

SODIUM VAPOR HIGHWAY LUMINAIRE

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